INDOOR AIR QUALITY ASSESSMENT

Wilmington Memorial Library
175 Middlesex Avenue
Wilmington, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Jeff Hull, Assistant Town Manager for the Town of Wilmington, the Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of the indoor air quality at the Wilmington Memorial Library (WML), 175 Middlesex Avenue, Wilmington, Massachusetts. On August 27, 2003, Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality Program (ER/IAQ), conducted the evaluation. Concerns about mold as a result of the excessively humid weather experienced during the first three weeks of August 2003 prompted the request. A letter was issued giving recommendations regarding remediation of mold growth and moisture issues within the building (MDPH, 2003). This report describes general indoor air quality conditions observed during the BEHA site visit.

The WML is a two-story red brick building that was constructed in 1968. The top floor contains the children's library, office space and conference rooms. The main floor contains general stack areas, circulation desk and office space. Original, single-paned, wooden sash windows are operable throughout the building, however occupants reported many of them are difficult to open.

Methods

BEHA staff performed a visual inspection of building materials for water damage and/or microbial growth. Air sampling for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The WML has a staff population of approximately 20 and can be visited by up to 100 members of the public daily. Tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million of air (ppm) in all areas surveyed, indicating adequate ventilation. However, it is important to note that the library was sparsely populated during the assessment, which can greatly reduce carbon dioxide levels.

Fresh air is supplied by a unit ventilator (univent) system (Picture 1). Univents draw air from outdoors through fresh air intakes located on the exterior walls of the building (Picture 2) and return air through air intakes located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated/cooled and provided to occupied areas through an air diffuser located in the top of the unit. Obstructions to airflow, such as papers and books stored on univents and shrubbery and plant growth outside were seen in a number of areas (Pictures 2 & 3). In order for univents to provide fresh air as designed, intakes must remain free of obstructions and remain activated while the library is occupied.

Exhaust ventilation is provided by wall and ceiling-mounted exhaust grilles (Picture 4). Exhaust vents are located in common areas throughout the building and are connected to rooftop motors via ductwork. Exhaust vents were operating during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation, the mechanical supply and exhaust systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room for offices (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings in occupied areas were measured in a range of 74^{o} F to 79^{o} F, some of which were slightly above the BEHA comfort guidelines in some areas during the assessment. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Cold complaints were expressed in the second floor restrooms, which appeared to have minimal provisions for heat.

The relative humidity measured in the building ranged from 52 to 62 percent, which was also slightly above the BEHA recommended comfort range in some areas. Outdoor relative humidity measured 50 percent the day of the assessment. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously mentioned, mold growth conditions that occurred in the library as a result of excessive relative humidity were addressed in a previous letter (MDPH, 2003). In addition to elevated relative humidity, several other potential sources of moisture accumulation/penetration exist in and around the exterior of the building:

- Univents provide air conditioning during summer months. The univent chilled-water pipes are not insulated and therefore are prone to condensation. When warm, moist air passes over a cooler surface (e.g., pipes, metal components to univent cabinets), condensation is formed and collects on the cold surface. Water damaged carpeting around univents was observed in a number of areas throughout the building (Picture 5).
- Missing/damaged mortar around bricks and holes and spaces were observed in exterior walls (Pictures 6 & 7). Water damaged wall plaster was seen in several areas as a result of water penetration through these breaches in the building envelope (Picture 8).
- Growth of small trees/stumps, and other plants were seen along the perimeter of the building (Picture 9). The growth of roots/plants against the foundation/exterior walls of the building can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level.
- Missing/damaged gutters and downspouts were seen in several areas (Picture 10 & 11). Gutters and downspouts are designed to direct rainwater away from the base of the exterior walls. In some cases the gutter/downspout system empties water directly against the foundation (Picture 12). These conditions can undermine the integrity of the building envelope and provide a means of water entry into the building through foundation concrete and masonry by capillary action (Lstiburek & Brennan, 2001).
- Picture 13 shows an area on the exterior of the building where flashing is missing/damaged.

- A number of areas had missing and/or water-damaged ceiling tiles (Picture 14), which is evidence of a roof or plumbing leak. Occupants reported that the roof leak had been repaired and no active leaks were present at the time of the assessment. Water-damaged ceiling tiles can provide a source of mold growth and should be replaced after a water leak is discovered and repaired.

Other Concerns

Periodic sewer gas odors were reported in the second floor restrooms. Restrooms are equipped with floor drains (Picture 15). Drains are designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without periodic input of water (e.g., 2-3 times per week), traps can dry and compromise the integrity of the watertight seal. If traps dry out, sewer odors/gases can travel up the drain into occupied areas.

Conclusions/Recommendations

The conditions noted at the WML raise a number of indoor air quality issues. The combination of the general building conditions, design, age and operation of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for implementation:

1. Continue to implement recommendations listed in previous BEHA correspondence (MDPH, 2003).
2. To maximize air exchange the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy independent of thermostat control.
3. Examine each univent for function. Survey rooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
4. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
5. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, continue to use the HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. Keep windows closed during hot, humid weather to maintain indoor temperatures and avoid condensation problems.
8. Insulate univent pipes to help prevent condensation.
9. Remove plants or relocate approximately five feet away from the exterior wall of the building to prevent water impingement.
10. Ensure all roof leaks are repaired. Repair/replace missing/damaged flashing along roof. Replace any remaining water-stained ceiling tiles. Examine the areas above and around these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
11. Repair dislodged/damaged gutters and downspouts. Replace elbow extensions to direct rainwater away from the foundation.
12. Seal open utility holes and spaces around vents on exterior of the building. Repair water damaged plaster on interior walls.
13. Pour water down floor drains in restrooms regularly (e.g., 2 to 3 times a week) to prevent sewer gas back up.
14. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

The following **long-term measures** should be considered:

1. Based on the age, physical condition and availability of parts of the HVAC system, the BEHA strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for proper operation, and/or repair/replacement considerations.

2. Consult with an architect and or general contractor regarding the integrity of the building envelope, primarily concerning water penetration through walls and the foundation. Examine the feasibility of repointing brickwork.

References

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Picture 1

Typical Unit Ventilator (Univent)

Picture 2

Univent Fresh Air Intake Obstructed by Shrubbery

Picture 3

Items on and in Front of Univent

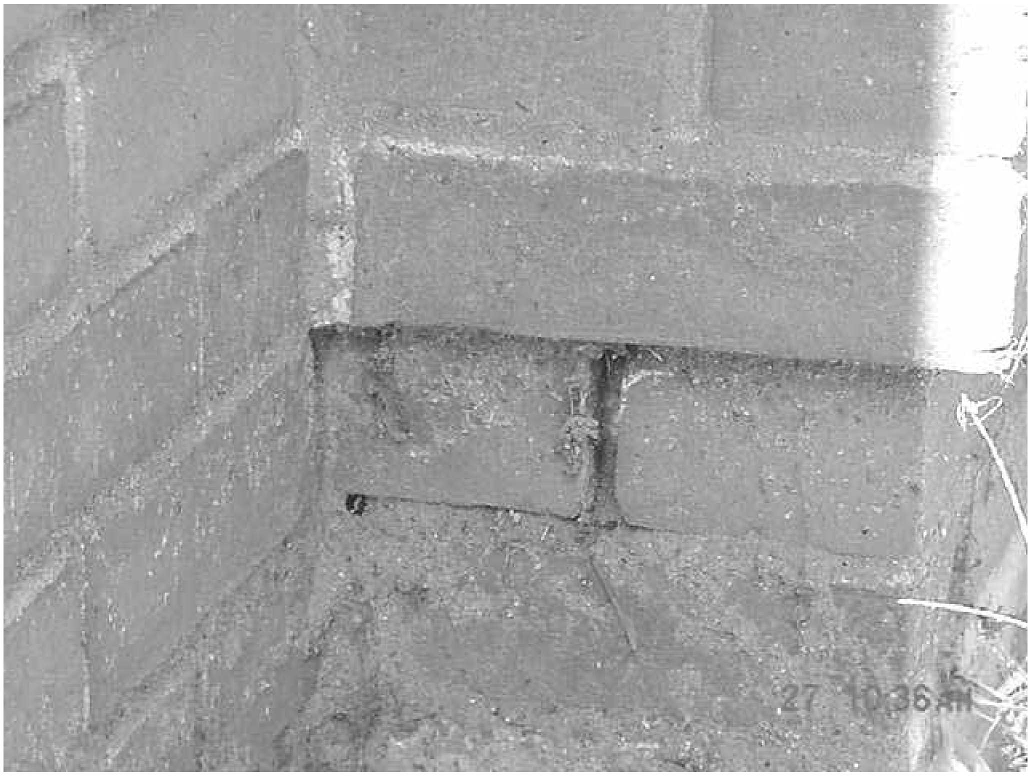
Picture 4

Wall Mounted Exhaust Vent

Picture 5

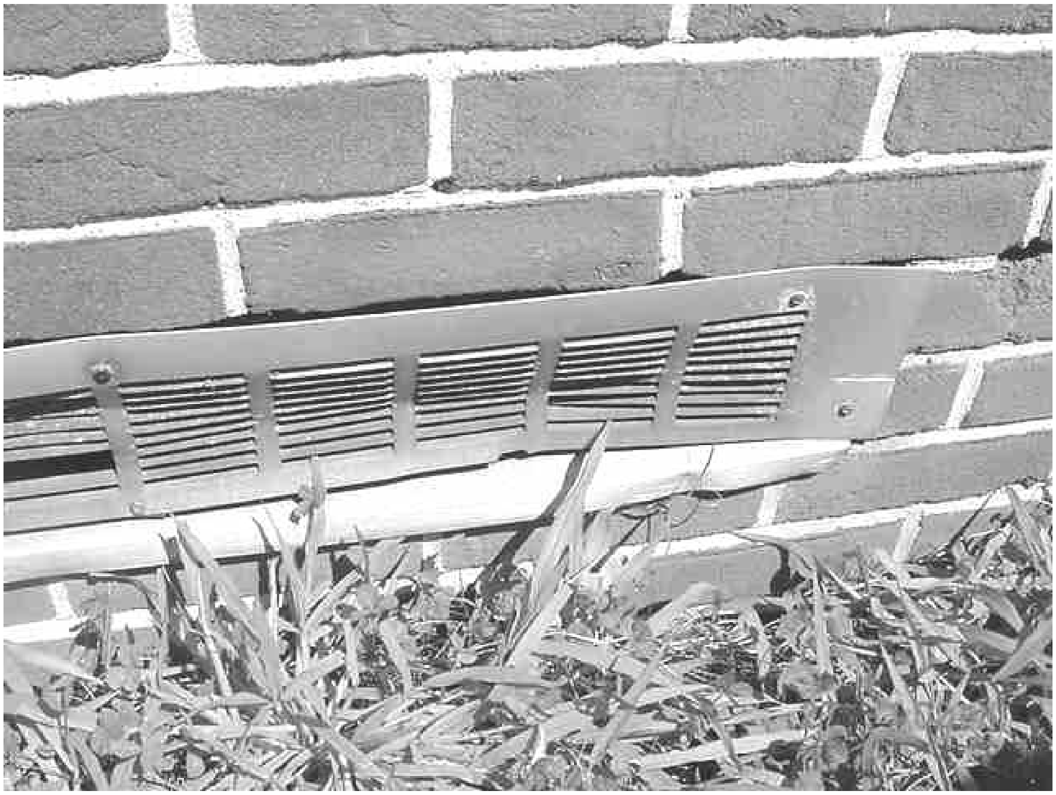
Water Damaged Carpeting (Corner) Near Univent in Front Foyer

Picture 6



Missing/Damaged Mortar around Brickwork

Picture 7



Spaces around Damaged Vent on Exterior Brick Wall

Picture 8

Water Damaged Wall Plaster in Technical Services Office, Note Wall Damage is Roughly Opposite Vent Shown in Picture 7

Picture 9

Shrubs and Plant Growth Against the Exterior of the Building

Picture 10

Dislodged Downspout along Roof of Building

Picture 11

Open Electrical Outlet (Utility Hole) and Downspout With Portion Cut Out, Note Moss Growth was Seen on the Brick Opposite Hole in Downspout

Picture 12

Downspout Missing Elbow at Base

Picture 13

Damaged Flashing Along Roof

Picture 14

Missing/Water Damaged Ceiling Tiles

Picture 15

Typical Floor Drain in Restroom

TABLE 1

Indoor Air Test Results – Wilmington Memorial Library, Wilmington, MA **Date: August 27, 2003**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	389	82	50					Weather Conditions: clear skies, winds NNW 5-10 mph
Front Foyer								Saturated carpeting – condensation univent (UV)
Conference Room	512	74	61	3	Y	Y	Y	
Rear Emergency Exit Hallway								WD CTs, leak repaired
Archive Room	435	75	62	0	Y	Y	Y	WD carpeting around UV
Children's Library	444	75	62	6	Y	Y	Y	Ceiling fans on WD carpet around UV- moderate moisture content
Children's Library Office	482	77	61	0	N	Y	Y	Items on UV (paper/cardboard)- musty odors reported by occupant
Staff Room	396	77	61	0	Y	Y	Y	Carpet moisture moderate
Children's Back Entrance								WD CTs, leak repaired
2nd Floor Restrooms								Cold complaints, periodic sewer gas odors

ppm = parts per million parts of air
WD = water damage
CT = ceiling tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Technical Services Office	496	79	57	0	Y	Y	Y	Mold growth on door jamb, efflorescence wall/corner near UV
Magazine Stacks	436	79	52	0	Y	Y	Y	Carpeting elevated Moisture (saturated)
900 Stacks	518	75	56	0	Y	Y	Y	
Perimeter Notes								Shrubbery in close contact with ext walls/air intakes, bees/wasps nests, gutter/downspouts dislodged, original wooden sash windows (diff to open), missing/damaged mortar brick

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